

with only one requiring surgical decompression. No neurologic or functional deficits have developed with this treatment regimen.

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Spinal Stenosis

THE ORIGIN OF SPINAL STENOSIS can be developmental, degenerative or a combination of both. In developmental stenosis there is a decreased interpedicular distance and a shortening of the pedicles, reducing the anteroposterior diameter of the canal. In the degenerative type, patients have canals of normal dimensions that become stenotic due to hypertrophic facets and lamina, posterolateral vertebral body osteophytes, disc herniation, ligament hypertrophy or spondylolisthesis. The stenosis can be in the central canal, the lateral recesses or at the intervertebral foramina.

Men are more commonly affected than women and the age of onset is usually in the fourth or fifth decade; however, it is seen in patients of all ages. Patients usually have both back and leg pains. About 40 percent will have pain in both legs that may be radicular. More often the leg pains are characterized by intermittent claudication, with patients describing a pain or heaviness in their legs, with or without muscle weakness, after walking a short distance. With a short period of rest the leg symptoms resolve, only to return again after an equally short distance of walking. These leg problems can be differentiated from a vascular origin by Doppler examination, electromyographic studies, bicycle exercise testing and arteriography.

On physical examination most patients are found to have absent reflexes and sensory and motor defects, but relatively few (less than 25 percent) have a positive result on straight-leg raising or Lasèque's test. With stenosis, if these test findings are positive, they will usually be positive bilaterally.

Narrowing of the canal and hypertrophy or subluxation (or both), which strongly suggest the diagnosis, can be seen on plain roentgenograms. The newer generation of computerized tomography scanners with their improved resolution

have been very helpful in the more difficult cases. Myelography studies will show posterior or lateral defects or an hourglass deformity at one or more levels and may show narrowing of the dural sac.

The only effective therapy is surgical decompression. It is important to be aware that in many cases the nerve compression is lateral under the hypertrophied facets. The laminectomy must extend laterally to decompress the nerve roots as far as the intervertebral foramina. This is accomplished by an undercutting partial facetectomy at all levels where preoperative studies have shown compression to be present.

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Vascularized Bone Grafts

VASCULARIZED GRAFTS of living bone offer an advantage over conventional nonvascularized grafts in that more osteocytes will survive and thus more rapid healing of bone will occur. Bone can be transferred as part of a composite tissue flap, along with skin and fat, and nourished by an attached vascular pedicle. The most common flap used in this manner is the groin flap, with a portion of the iliac crest nourished by the superficial or deep circumflex iliac artery and veins. Only relatively small defects can be covered by this type of flap and it cannot be transferred to the leg in a single stage except as a free flap.

Free vascularized bone grafts for defects in long bones caused by tumor or trauma have been possible with the development of microvascular surgical techniques. A recent review of the role of vascularized grafts in bone grafting has shown that for defects less than 6 cm conventional autogenous bone grafting techniques will generally work satisfactorily. For defects larger than 6 cm vascularized grafts are more satisfactory than conventional techniques.

The most suitable donor bone for long bone defects is the fibula. This bone is transferred on a vascularized pedicle of the peroneal artery and accompanying venae comitantes. Attached peroneus brevis muscle and overlying skin can also be transferred with this flap if needed as a functional motor and if the nerve supply to the

muscle can be reattached to a motor nerve at the recipient site.

Weiland and associates have recently reported on the cases of ten patients who underwent en bloc resection of a tumor or benign lesion and immediate reconstruction of the defect with free vascularized fibular grafts. Lesions resected included low grade chondrosarcoma, giant cell tumor, adamantinoma, fibrosarcoma and congenital pseudarthrosis of the tibia. Although the leg must be protected from weight bearing early on, all patients were fully weight bearing by 4 to 12 months postoperatively. Grafts were found to hypertrophy and only one failure was noted.

With the possibility of free vascularized bone grafts, the treatment horizons of preserving functional limbs can be expanded with low grade malignant and locally aggressive tumors. One can do adequate en bloc resection of a tumor without fear of creating a bone defect too large for reconstruction.

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The Role of Hyperbaric Oxygen in Orthopedics

HYPERBARIC OXYGEN (HBO) increases tissue oxygenation by a factor of ten or more. It is administered by placing a patient in a monoplace (one-man) or multiplace chamber and pressurizing the vessel to two to three atmospheres absolute (1,520 to 2,280 mm of mercury). The monoplace chamber is pressurized with oxygen and a patient breathes the oxygen in the chamber directly. The multiplace chamber is pressurized with air and pure oxygen is breathed by a patient through a mask. At three atmospheres pressure (2,280 mm of mercury) enough oxygen becomes dissolved in plasma to meet tissue needs in the absence of hemoglobin-borne oxygen. HBO supplements the oxygenation of ischemic tissues caused by low flow states, edema or anemia.

Gas gangrene, chronic refractory osteomyelitis and crush injury are the three orthopedic conditions for which HBO is most frequently given. However, it has been used in 31 other orthopedically related problems.

In the past HBO was used empirically, but today

information exists for its rational application. For example, in gas gangrene it was thought that HBO's primary role was to kill clostridial organisms. Actually HBO first halts formation of deadly α -toxin and, second, it stops bacterial proliferation. The use of HBO in gas gangrene is adjunctive, as shown in the study of Demello and co-workers in which dog survival rates were improved 25 percent with HBO.

Misconceptions also existed in the use of HBO for the management of chronic refractory osteomyelitis. Instead of inhibiting growth of the offending organism, as originally thought, HBO helps to oxygenate the ischemic environment around the focus of infection sufficiently for leukocytes to kill microbes by oxidative mechanisms (Mader and associates).

In crush injuries and acute peripheral ischemias perfusion is often so compromised that repair processes ordinarily cannot occur (Strauss). Specific tissue oxygen tensions are required for neovascularization and fibroblast proliferation. HBO helps achieve these baseline tensions. This is also the proposed mechanism for HBO's usefulness in related conditions such as replantation operations, frostbite and compromised skin grafts.

There are two promising new uses of HBO in orthopedics. The first is in patients whose circulation is compromised, such as those who have diabetes or arteriosclerosis and those who have radiation vasculitis with infected, nonhealing wounds. Limb salvage is considerably improved when HBO is added to a comprehensive wound management regimen. Also, HBO substantially reduces muscle necrosis and edema in dogs that have experimentally induced intramuscular compartment syndromes.

Hyperbaric oxygen is remarkably free of untoward side effects. Complications such as oxygen toxicity, middle ear barotrauma and confinement anxiety are well controlled with appropriate pre-exposure orientations, medications and treatment schedules. Contraindications to HBO are few. Fever, acidosis and dehydration lower the threshold for oxygen toxicity and should be corrected before treatments are started. Nicotine use makes HBO ineffective and should be discontinued during the course of treatments. Viremias may become fulminating infections during HBO exposure and thus are an absolute contraindication to its use. Pregnancy is a relative contraindication because of possible teratogenic effects.

Orthopedic indications for HBO will become